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IP Indian Journal of Anatomy and Surgery of Head, Neck and Brain

Journal homepage: https://www.ijashnb.org/

Case Report

A rare anatomical star shaped branching pattern of spinal accessory nerve: A case report with review of literature

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ARTICLE INFO

Article history:
Received 14-07-2022
Accepted 03-10-2022
Available online 21-10-2022

Keywords:
Spinal Accessory Nerve
Neck Dissection
Cervical plexus
Macroganglia
Star shaped variation

ABSTRACT

The spinal accessory nerve provides motor innervation to the sternocleidomastoid and trapezius muscle. It is an extremely important structure to be preserved during neck dissection to avoid sequalae related to shoulder dysfunctions. The incidence of shoulder dysfunction and morbidity can be attributed to varied anatomy and branching pattern of the nerve or the contribution by the cervical plexus to the motor innervations of the trapezius muscle. Hence it is important to have knowledge of the varied anatomy and branching pattern of the spinal accessory nerve to avoid the possible shoulder morbidity and dysfunction following neck dissections. Lanisnik B etal's study showed that there are three recognizable branching patterns of the spinal accessory nerve for innervation of the trapezius muscle. In type 1, the SAN enters the Sternocleidomastoid muscle and a single trapezius muscle branch exits from the posterior border of the SCM after receiving communications from the cervical nerves, especially C2 and C3. In type 2, the motor branch for trapezius muscle separates from the main trunk at level II, before the nerve enters the sternocleido-mastoid muscle. In the type 3 pattern, CN XI enters the SCM in the same way as described in type 1, and the motor branch for the trapezius muscle exits from the SCM muscle behind its posterior border; however, it does not immediately travel to level V and the trapezius muscle, but instead takes a more medial course and mixes with the cervical nerves, predominantly C2 and C3. In this case report, we will discuss an unusual branching pattern of spinal accessory nerve similar to the type 3 variant as explained by Lanisnik that we have encountered during a modified radical neck dissection, in a case of Squamous cell carcinoma of right buccal mucosa.

1. Introductions

The spinal accessory nerve (SAN) arises from the cervical spinal cord (level C1-C5) from a column of ventral horn cells that together are called accessory nucleus. The spinal accessory rootlets exit the cervical cord and unite to form a single spinal root that ascends posterior to the dentate ligament, enters the cranium via the foramen magnum, and then exits the cranium through the pars vascularis of the jugular foramen. The accessory nerve then descends obliquely into the carotid space between the internal carotid artery (ICA) and the internal jugular vein (IJV), across the anterior surface of the atlantal transverse process posterior to the stylohyoid and digastric muscle to enter the deep aspect of the sternocleidomastoid muscle, which it penetrates and supplies. Emerging lateral to the sternocleidomastoid muscle (SCM), in close proximity to the greater auricular nerve, it crosses the posterior cervical triangle on the surface of the levator scapulae muscle to end in and supply the trapezius muscle.

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https://doi.org/10.18231/j.ijashnb.2022.025

The cranial root of the accessory nerve is a group of fibers that arise from the caudal portion of nucleus ambiguus and emerge from medulla. Along with the vagus nerve proper, the cranial root runs laterally in the cerebellomedullary cistern and passes through the pars vascularis of the jugular foramen. At the level of superior vagal ganglion the cranial root blends into the vagus nerve and to supply pharynx and larynx.[1]

The spinal accessory nerve provides motor innervation to the sternocleidomastoid and trapezius muscle. It is an extremely important structure to be preserved during neck dissection to avoid sequelae related to shoulder dysfunctions. The identification of anatomical variations of CN XI branching in the neck provides invaluable information to surgeons seeking to preserve the motor branches of CN XI during neck dissection. Despite using nerve sparing techniques, there is some amount of shoulder morbidity recorded during few modified radical neck dissection or selective neck dissection techniques. The incidence of shoulder dysfunction and morbidity can be attributed to varied anatomy and branching pattern of the nerve or the contribution by the cervical plexus to the motor innervations to the trapezius muscle. Hence, it is important to have knowledge of the varied anatomy and branching pattern of the spinal accessory nerve to avoid the possible shoulder morbidity and dysfunction following neck dissections.

Lanisnik B et al's[2] study showed that there are three recognizable patterns of the spinal accessory nerve branching for innervation to the trapezius muscle. In type 1, the SAN enters the Sternocleidomastoid muscle and a single trapezius muscle branch exits from the posterior border of the SCM after receiving communications from the cervical nerves, especially C2 and C3. This pattern has been identified in 66%patients as shown in Figure 1. In type 2, the motor branch for trapezius muscle separates from the main trunk at level II, before the nerve enters the sternocleidomastoid muscle. This pattern is seen in 22% of patients undergoing neck dissections as shown in Figure 2. In type 3 pattern, CN XI enters the SCM in the same way as described in type 1, and the motor branch for the trapezius muscle exits from the SCM muscle behind its posterior border; however, it does not immediately travel to level V and the trapezius muscle, but instead takes a more medial course and mixes with the cervical nerves, predominantly C2 and C3. This variant is the least common and is found in only 12% of neck dissections as shown in Figure 3. In this case report we will discuss an unusual branching pattern of spinal accessory nerve similar to the type 3 variant as explained by Lanisnik that we have encountered during a modified radical neck dissection, in a case of Squamous cell carcinoma of right buccal mucosa.

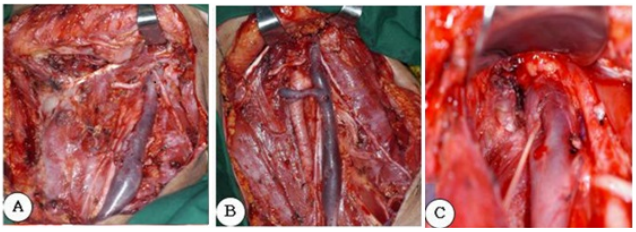

Fig. 1: Relationship between the course of the spinal accessory nerve (SAN) and internal jugular vein (IJV). (A) SAN (left) crosses the left IJV on the ventral side. (B) SAN (left) crosses the left IJV on the dorsal side. (C) SAN (right) passes through the right IJV.(Source: Lee SH, Lee JK, Jin SM, Kim JH, Park IS, Chu HR, Ahn HY, Rho YS. Anatomical variations of the spinal accessory nerve and its relevance to level IIb lymph nodes. Otolaryngology–Head and Neck Surgery. 2009 Nov;141(5):639-44.)

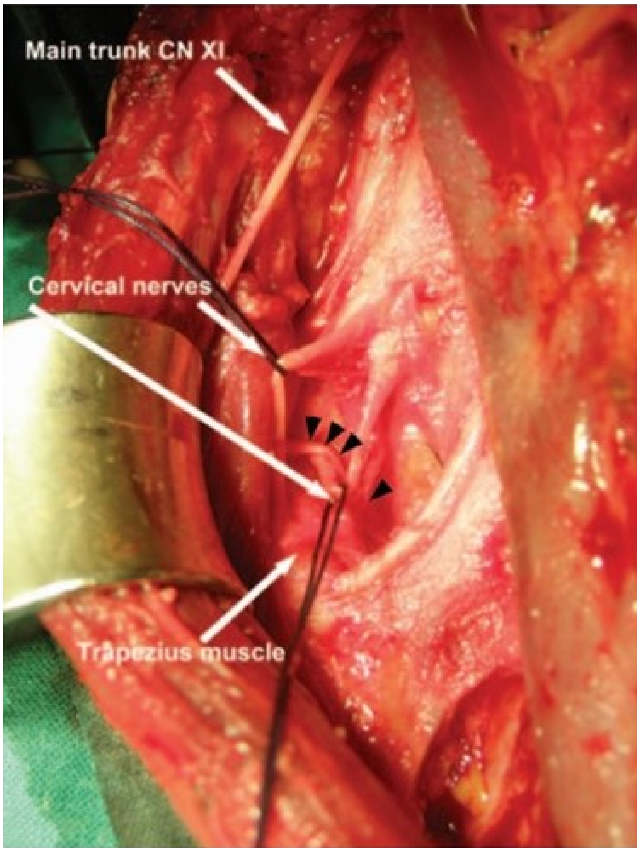

Fig. 2: Type 1 branching of CN XI where the main trunk of CN XI is shown at the posterior triangle and the cervical nerves ares retracted with suture loops reveals the motor branch for the trapezius muscle passing below the muscle.

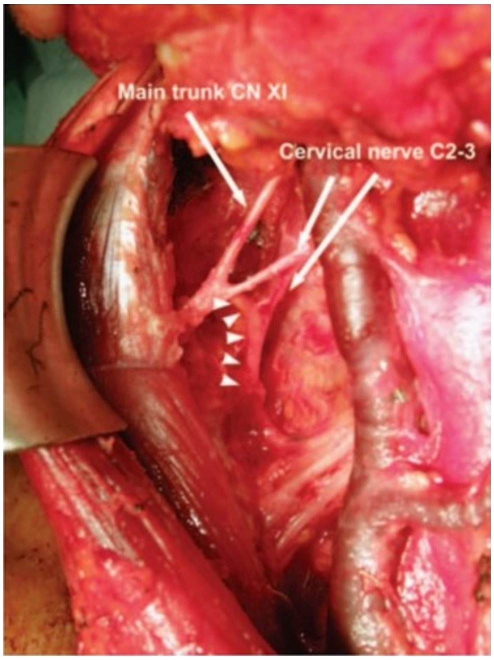

Fig. 3: Type 2 branching of CN XI where the main trunk of CN XI can be seen entering the SCM, branching toward the Trapezius immediately prior to entry and cervical nerves are clearly visible communicating with CN XI.

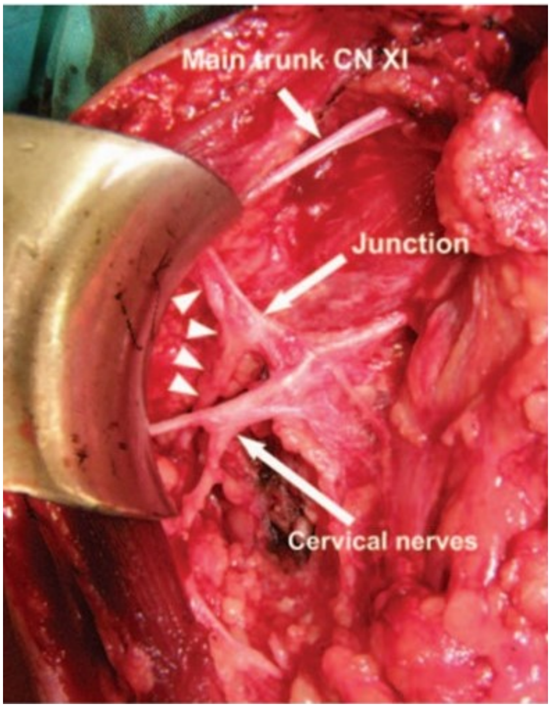

Fig. 4: Type 3 branching of CN XI where the main trunk of CN XI can be seen entering the SCM, branching toward the trapezius immediately prior to entry.

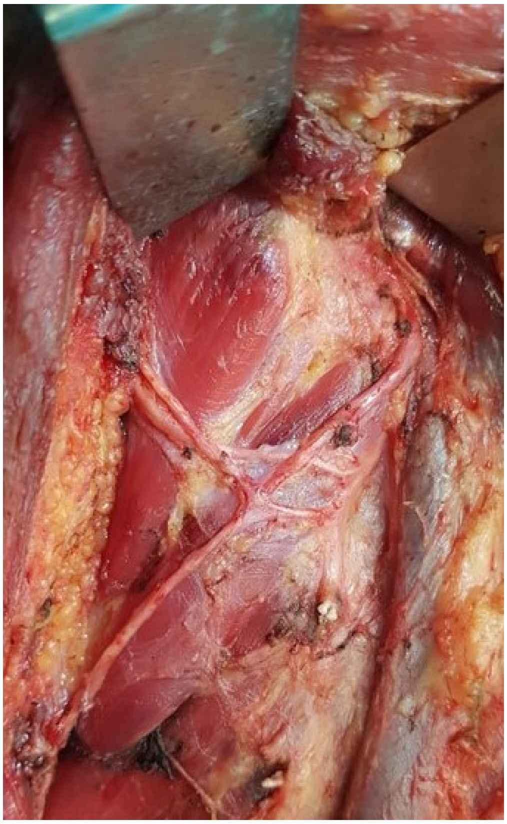

Fig. 5: A "star shaped" branching pattern of the SAN during its communication with the cervical rootlets (C2,C3) as seen in our case.

2. Case Report

A 53 years old male diagnosed with Squamous Cell Carcinoma of the right buccal mucosa, (CT4AN0MO) was planned for surgery (Right buccal mucosa WLE+ right modified radical neck dissection+ Pectoralis Major Myocutaneous flap reconstruction) under general anesthesia.

Right angle of mouth incision extending to the neck was taken and sub-platysmal flap raised. The neck dissection was started with identification of superior landmarks as posterior belly of digastric muscle and inferior landmark as the clavicle. Carotid sheath was opened and IJV was identified. Blunt dissection was done on the superior aspect at the junction of IJV, SCM, and posterior belly of digastric. Spinal accessory nerve was identified and the course of nerve was traced through the SCM muscle with identification of sternomastoid and trapezius branches. After its exit from the posterior border of the sternocleidomastoid muscle an unusual branching pattern with communications with the cervical rootlets (C2, C3) was seen which resembled a macro-ganglion and we called it a *"star shaped"* branching pattern as shown in Figure 4.

3. Discussion

The knowledge of varied anatomy, branching pattern and careful identification of spinal accessory nerve is important to avoid any form of iatrogenic injury and any possible morbidity in form of shoulder syndrome.[3] The most common variation in the spinal accessory nerve was studied in relation to the IJV in a study by Lee S et al.[3] In the mentioned study a total number of 126 neck dissections were observed and it was found that, the SAN crossed the IJV dorsally in 104 cases (57.4%), and ventrally in 72 cases (39.8%) and passed through the IJV in five cases (2.8%). The SAN sent a branch to the SCM that penetrated the muscle in 96 cases (53.4%) while in 83 cases (45.9%) the SAN ran along the inner surface of the SCM and sent a branch to the SCM without penetrating it. Contributions from the cervical plexus to the SAN were seen in C2 in 96 cases (53.1%), C2 and C3 combined in 69 cases (38.1%), and C3 in 16 cases (8.8%). In 55 cases in which bilateral neck dissection was performed, the neck was compared bilaterally for assessment of symmetry. The relationship between the SAN and the IJV, SCM, and cervical plexus was bilaterally symmetrical in 84.1 percent, 81.5 percent, and 72.3 percent, respectively.[3]

Similar findings on branching pattern of SAN while traversing the SCM and trapezius muscle were published by Shiozaki et al.[4] who performed a detailed cadaveric anatomical study with special emphasis on patterns of SCM innervation. Shiozaki et al.[5] characterized three main types of SCM innervation: a non penetrating type (type A), a type partially penetrating the SCM (type B) and a type completely penetrating the SCM (type C). In type A, accessory nerve branch innervates the sternocleidomastoid muscle from the cleidomastiod region, while the main trunk of the accessory nerve runs along the inner surface of the sternocleidomastoid muscle without penetrating it and heads towards the trapezius. In type B, the main trunk of the accessory nerve penetrates the sternocleidomastoid muscle in the cleidomastoid region, then re-appear on the inner surface of the muscle and finally proceeds towards the trapezius. Type C variant shows that the main trunk innervates the SCM from the cleidomastoid junction, completely penetrated it on the lateral surface of the muscle, exits it and heads towards the trapezius. The authors also described five different types of trapezius branching patterns according to the number of branches that innervate the anterior margin of the muscle. In Type 0 (3.8%) no branches innervated anterior margin of the trapezius muscle. In type 1(50%),1 branch innervates the anterior margin; in Type 2 (30.8%), Type 3 (11.5%) and Type 4 (7.9%), 2, 3 and 4 branches were seen innervating the anterior border of the trapezius respectively.

Relation of trapezius muscle innervation and function to the cervical nerves comes from the embryology of CN XI. Tubbs et al.[5] reported that connections between CN XI and mainly medial cervical roots were observable in 30% of dissections. Using immunohistochemistry, the author showed that the medial roots were motor on two sides, whereas all lateral roots were purely sensory. These findings may also explain the observation of sensory deficits and pain after some cases of CN XI injury. In the study by Gavid et al.[6] physiological evaluation of the contribution of cervical nerves to motor innervation of the trapezius muscle was observed. The results demonstrated at least one communicating branch between C2–C4 and the spinal root of CN XI in 23 different dissections. The most common branch was observed coursing between C2 and the spinal root of CN XI. Moreover, compound muscle action potentials (CMAPs) were recorded in eight of 25 dissections (32%).

However, Soo et al.[7] showed variable responses of the trapezius muscle to cervical root stimulation in 30% of patients. It was concluded that spinal accessory nerve was the most important innervation source for the trapezius muscle, whereas the cervical nerves provided an unpredictable, lesser degree of innervation.

Findings regarding the anatomical patterns of CN XI and cervical nerve innervation of the trapezius muscle could have implications for the development of a modified radical neck dissection (MRND) technique. Decreased postoperative shoulder function after intraoperative CN XI damage may be to some extent related to the surgical technique used during neck dissection. Research has clearly shown that damage to SAN typically occurs at level IIa/IIb, where the nerve is subjected to maximal traction and devascularization during surgery. The severity of functional damage at 6 weeks post surgery correlates with final postoperative shoulder function. To this end, it has been shown that the extent of surgery correlates with postoperative shoulder morbidity, and that patients have better functional scores after selective neck dissection versus MRND.[8–11] The branching pattern that we had encountered during neck dissection resembled the type 3 branching pattern as described by Lanisnik et al where after exiting the posterior border of the sternocleidomastoid muscle the nerve took a medial course to form a plexus with the C2 and C3 cervical rootlets to form a “star shaped” pattern before entering into the anterior border of the trapezius muscle. This type of branching pattern is both rare and exhibit more intimate relation with the cervical nerves. Some authors have advocated that these type of branching patterns in which communications between cervical nerves and SAN are responsible for trapezius muscle motor function even in radical neck dissections where SAN is transected, but communicating branches at the terminal end of SAN are preserved. Our patient was subsequently followed up in the immediate and late post operative period up to 2 months and no shoulder dysfunction or shoulder morbidity was observed.

4. Conclusion

Identification of anatomical variations of CN XI branching in the neck provides invaluable information to surgeons seeking to preserve the motor branches of CN XI during neck dissection. As the exact role of cervical nerve innervations to the trapezius muscle is still unclear, these nerves should be preserved whenever possible. Preservation of the cervical nerves could help to minimize pain and associated shoulder morbidity not attributable to CN XI damage after neck dissection. The use of intraoperative nerve monitoring during neck dissection may be helpful for improving surgical outcomes in certain cases but cannot be taken as a confirm method to preserve the nerve during surgery. Sound knowledge of anatomy, use of blunt dissection, maintaining a bloodless field of surgery for better visibility and maintaining a proper plane of dissection are few of the most promising steps in preserving the nerve and thus reduce shoulder dysfunctions and deformities related to severing of the spinal accessory nerve.

5. Consent

Written informed consent for publication of the patient's details was obtained.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare that they have no conflict of interest

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Cite this article: Banerjee M, Kantharia RA, Kantharia SR, Teli ZA. A rare anatomical star shaped branching pattern of spinal accessory nerve: A case report with review of literature. *IP Indian J Anat Surg Head, Neck Brain* 2022;8(3):104-108.